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REVIEW OF LITERATURE ON STREAM POLLUTION - 1948

Environmental Health Center
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In discussing stream pollution abatement Weston[38] pointed out that the industrialist has a golden opportunity to perform a public service and obtain the goodwill of the public and at the same time help himself by working seriously for abatement. He suggests that besides the hygienic, economic, aesthetic, and legal considerations, pollution may involve another consideration, i.e., that of industrial public relations. Following his discussion of the various effects of pollution, the losses through litigation and the political aspects, Weston urges the establishment of an organization of technical representatives to collect and promote the exchange of knowledge on pollution abatement problems of mutual interest to all industry in an area. Anable and Kite,[11] on the other hand, consider that the legislative aspect of pollution abatement is the most important consideration for coordinating the technical and financial activities of industry in the long range attack on this problem. They suggest that industry can never have any incentive or other reason for reducing pollution except to meet the standard required by the pollution control agencies in the area directly covered. Their viewpoint gives no consideration to the aspect of public relations or goodwill as an incentive for pollution control and seems to justify the view held by some that more stringent legislation is needed.

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A model sanitation code designed to aid communities in abating and controlling water pollution problems was developed by the Special Committee on Pollution Abatement of the Joint Legislative Committee of New York and sent to officials of New York State cities, towns, and villages [7]. This model code has seven sections which: (1) require sewer connections, (2) prohibit pollution of ground and waters, (3) define conditions of installation of septic tanks and the disposal of tank effluents, (4) define conditions for the additions to disposal systems, (5) prohibit the disposal of refuse in an unsanitary manner, and (6) provides fines and penalties for violations of the provisions and requirements. A bill was introduced in the New York State Legislature to create a Water Pollution Control Board in the State Board of Health with authority to deal with pollution problems [9].

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It was pointed out editorially [5] that before most industries in the Potomac River basin install additional processing equipment, the possible effect of the new installations on the pollution of the stream must be reported to top officials of the company. The manner in which industry in this area has shouldered its pollution abatement responsibilities not only reflects to the credit of industrial management, but also indicates the effectiveness of the youthful Interstate Commission on the Potomac Basin as an interstate pollution control agency. In West Virginia, Watson [7] described a long range program to abate and control stream pollution which has for its immediate objectives: (1) stream classification of all waters in the state into one of four water quality zones, (2) the cooperative improvement of industrial

stream pollution, and (3) the education and municipal planning toward sewage treatment. Although only 10.4 percent of the states sewered population now has sewage treatment, treatment facilities for 65 percent of the sewered population is in the planning stage.

King [24] suggests that reasonable and workable stream pollution abatement regulations be developed by the state while industry develops controls and methods for its own waste treatment. He stated that chemical industry is aware of the challenge of the pollution abatement problem, and for the need for industry to treat discharged wastes so that, (1) the stream is not harmed to an objectionable degree, (2) the effluent will not make the stream acid nor consume more than a reasonable part of the stream's acid neutralizing power, and (3) not more than a fixed percentage of the stream's dissolved oxygen will be consumed.

Walker [36] stated that the River Boards Bill in England, when enacted, will set up Boards in various sections of the country for prevention of pollution, but the Boards will be limited by not having sufficient statutory power.

Parker [28] pointed out that the municipality is solely liable for pollution where testimony proves that industrial firms and others comply with municipal ordinances and regulations. However, any user of a sewer who overloads it or violates valid laws may be liable for the pollution of water to the detriment of owners of private property. Where an analysis can be made for direct and demonstrative proof of an injury, the loss of the suit may result if this essential step is omitted.

The Sanitary Water Board of Pennsylvania (2) won an important case against a coal company in its abatement program. Investigation showed that the killing of fish in Aunt Clara's Fork of Kings Creek was caused by dumping of strip mining wastes and the case was decided in favor of the Board. This Board (1) has issued orders to Publicker Industries of Philadelphia to insure continued abatement of pollution of the Delaware River. This Board (4) also cited a cannery for alleged discharge of chemicals which killed fish in Conewago Creek.

In California, the state (3) has cited 22 communities to force action on sewage treatment to abate stream pollution.

Sverc (35) stated that although there are stream pollution problems of considerable magnitude in North Dakota, the state has appropriated no money for pollution control or investigation.

The Ohio River Valley Water Sanitation Compact (27) which created a sanitation district that embraces all territory within the signatory states, the water in which flows ultimately into the Ohio, was signed on June 30, 1948 by representatives of Illinois, Indiana, Kentucky, New York, Ohio, Pennsylvania, Tennessee and West Virginia. This compact provides for an Ohio River Valley Sanitation Commission having three commissioners from each signatory state and three representing the United States Government. The Commission is authorized to adopt, prescribe and promulgate rules, regulations and standards for administering and enforcing the control and abatement of stream pollution within the District.

The Federal Stream Pollution Control Act [6] known as Public Law 845 was passed. This law authorizes a comprehensive water pollution control program by the United States Public Health Service, and establishes a 10 man Water Pollution Control Advisory Board. Either the Surgeon General of the Public Health Service, or a Sanitary Engineer Officer designated by him is to be chairman of this board. The Board includes one representative from each of, the Department of the Army, the Department of Agriculture, Department of the Interior, and the Federal Works Agency, and six persons, who are not officers or employees of the government, to be appointed by the President. Fourteen river basin offices will implement the program and will cooperate with state and interstate agencies, with municipalities and with industry in their respective watersheds. Research and technical service facilities of the Public Health Service laboratory at Cincinnati are authorized in this program.

Biology and Bacteriology

Bartsch [12] discussed the biological aspects of stream pollution from two points of view: (1) how pollutants change the character of the stream as a habitat for organisms, and (2) the action of organisms upon the pollutant and their related distribution. The distribution of living organisms is altered by pollution and may be used to complete the pollutional picture obtained by the usual testing procedures. A British Field Sports [5] Society report records the gradual destruction of salmon fisheries as the result of pollution from sewage

and industrial waste. Hora and Mair [22] in India reported that although the effluent from a quinine factory had no apparent direct injurious effect on fish life, the deposit of bark residues affected the feeding grounds. Reid [29] reported that the discharge of lime slurry had a deleterious effect on plant and plankton life.

In studies on the effect of acid and alkalies on fish, Stiemke and Eckenfelder [34] found that bluegill fingerlings reacted differently according either to their stage of development or the season. They reported that alkalies cause more violent death than acids. They proposed the following formula to correlate the pH value and acidity at the time of death:

$$(ph) \qquad (\text{Log } C)^n = K_E$$

where C = concentration as p.p.m. expressed as $CaCO_3$

n = constant depending upon the type of acid

K_E = Eckenfelder's number which was found to have a relatively constant value at 7.4 at the average death point for all acids used. Curves were presented showing the variation between pH and K_E. It was suggested that by using these curves and with the knowledge of the death point for any acid expressed either as pH or K_E one can quickly determine the maximum reduction in pH that can be tolerated in a stream by discharge of an acid waste without harmful effect on the fish.

Stefanile [33] contributed a comparative study of media for the isolation of E. typhi in polluted waters. The medium of Leifson detected more contaminated samples than the Kaufmann-Miller, and the Wilson Blair medium was used for isolating E. typhi. A study of the enumeration of Fecal Streptococci in river water with a modification of the medium of Mann and Perry consisting of buffered glucose broth

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containing azide in a concentration of 1 in 4,000 and peptone in place of tryptone was made by Mannay and Norton [21a]. Although the maximum count in the presence of azide was not obtained until 72 hours of incubation, both 24 and 48 hour cultures containing azide gave a higher maximum count than the medium containing no azide.

Chemistry

Verloo [39] reported that the oxygen absorbed from permanganate depends upon the dilution of the sample and recommends that a standard dilution be accepted to make the results more consistent and comparable. Another modification of the permanganate oxygen absorbed procedure in which the acidified sample treated with 1 ml. of .025 N $KMnO_4$ is boiled for 10 minutes is recommended by Zielenikewa [40] for field conditions. Ingols developed another dichromate reflux oxygen consumed procedure. In this method the sample is refluxed for 60 minutes with 25 ml. of the oxidizing reagent (1 volume concentrated H_2SO_4, 1 volume 85% H_3PO_4 and 1.25 g. of $K_2Cr_2O_7$), using selenium as a catylst. The excess $K_2Cr_2O_7$ is determined iodometrically as in the Rhamo method which was reviewed last year. In view of the need for an improved oxygen consumed procedure in stream pollution studies, these procedures deserve further careful study.

Basavilbasa [13] and Ettinger and Ruchhoft [19] studied procedures for the determination of phenol and structurally related compounds with the Gibbs reagent in polluted waters. In the Basavilbasa procedure the sample is treated with a $MnSO_4$-$CuSO_4$ reagent to eliminate sulfides and

dissolved oxygen following which the color is developed with Gibbs reagent in a borate buffered solution and extracted with iso-amyl alcohol. Factors affecting the amount and characteristics of the color produced by the Gibbs reagent, studied by Ettinger and Ruchhoft, included reaction time, temperature, pH, and the 2-6,dibromoquinone chloramide used. Spectrophotometric examination showed that the colors produced varied with the phenolic compound. The details of a procedure designed to take due account of the variables are presented and recommended for application to stream pollution studies where the concentration of these compounds may be very low (under 100 p.p.b.).

Stream Sanitation and Dissolved Oxygen Balance

Lawrence [25] applied the standard oxygen consumed test to the study of the time of passage of pollution (waste sulfite liquor, paper mill wastes with some sewage) in the Androscoggin River. This procedure showed a well defined molecular front in the river. The cold permanganate number was quite sensitive to small changes in H_2S, and the difference between the hot and cold permanganate numbers gave a valuable index of the fate of a given pollution load.

Crawford [15] studied the dissolved oxygen fluctuations on a typical swamp stream and the effects of sulfate, pulp and paper mill discharges to the stream. He concluded that the existing concepts of 4.0 to 5.0 p.p.m. of dissolved oxygen for the proper support of aquatic life are not applicable to swamp streams and that the maintenance of an average of 2.5 p.p.m. with a minimum of 2.0 p.p.m. would

be satisfactory for native fish life and the esthetic characteristics of the river.

Abbott [10] found photosynthesis an important item in the complex changes occurring in sewage irrigation and devised a means for determining the biochemical production of oxygen. He suggests that the oxygen producing capabilities of a sample be determined by incubating duplicate portions at the same temperature in the dark and in the light from a north window for 48 hours.

Studies by Ruchhoft, et al [30,31] and Cotano [21] that appeared during the year, which dealt with the biochemical oxygen demand of sewage dilutions, should be mentioned here because of the importance of this parameter in stream studies. These studies indicated that although the general course of the biochemical oxidation in sewage dilutions follows the unimolecular reaction, the values of the velocity constant K at a given temperature varies much more than was considered probable and the average value of K at 20°C. is considerably higher than the commonly used value of 0.1 found by Phelps and Theriault. The incidence of early nitrification and the affect of early nitrite formation upon the derivation of velocity constants for the first stage obtained by common B.O.D. observations was reported by Ruchhoft, Placak and Ettinger [31]. These studies in which errors due to the formation of minute quantities of nitrite were eliminated showed a range of K values for first stage oxidation on 45 samples at 20°C. between .07 and .25 with a skew distribution pattern in which values between 0.16 and 0.20 occurred most frequently. Cotano [21] concluded

that the magnitudes of the ultimate first stage biochemical oxygen demands of sewage are not affected significantly in the range of 5°C. to 30°C., which does not agree with the commonly accepted view that the ultimate first stage B.O.D. increases 2% for each degree increase in temperature.

Standards

Ellmaker [15] discussed the classification of all waters into four common groups: (1) sources of drinking water and for cultivation of shellfish, (2) waters used for bathing, (3) recreational and industrial waters, and (4) waters used for commercial navigation and transportation of wastes. Sarirk [32] reported that although the permissible limit of nitrate is not definitely established, water containing 94 to 140 p.p.m. raised varying degrees of severity in cases of methemoglobinemia (blue babies). Dagna[16] suggests 10 p.p.m. of nitrate as the maximum that can be safely used in baby feeding formulae.

Surveys

Lieberman and Hoover [26] studied the effect of forest practices on water quality in the 5,500 acre laboratory of the Southeastern Forest Experiment Station situated in the Pratchala Range of the southern Appalachian Mountains. They found that run-off and inorganic slow settling turbidity is greatly increased by logging. Data from controlled logging areas are given. The turbidities are due to soil erosion which results from unplanned and poorly constructed roads.

Fology, Johnson and Westfield [20] described a study of acid mine water and reported that the main streams and rivers that flow through the anthracite region of Pennsylvania are nearly always alkaline at all points within the region itself. Under present conditions the acid mine drainage appears to be beneficial to the municipalities along the banks because of its neutralizing action on the highly alkaline sewage and industrial wastes. Camp [14] contributed a comprehensive report of the pollution of the Merrimac River by Lowell and Lawrence and surrounding territory of which 77.5% of the B.O.D. is due to industrial waste. A Study of the Pollution of the Black Warrior River above Tuscaloosa, Alabama was reported by Dunstan [17].

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